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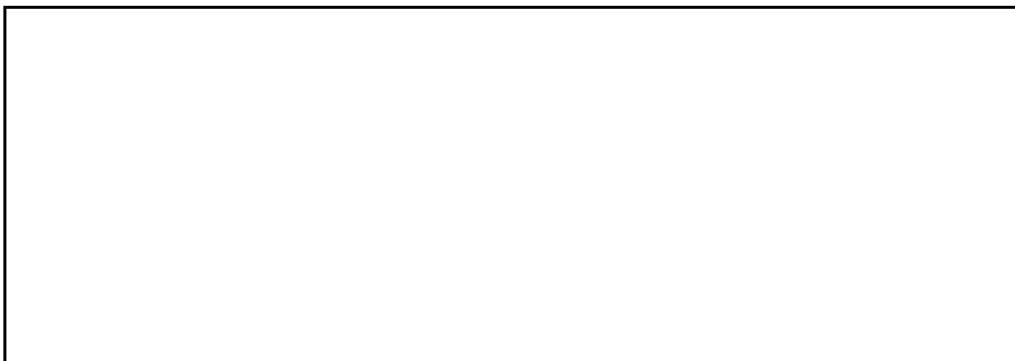
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A MODEL TO DETERMINE THE RESULTS OF ALTERNATIVE OPEC PRICES

Prepared For



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CIA/OER

29 March 1974



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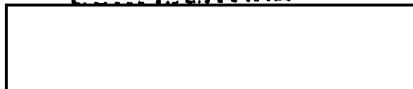
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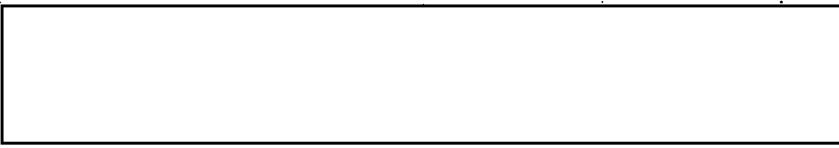
A Model to Determine the Results of Alternative OPEC Prices

Approach

This paper considers the international oil market from the perspective of the OPEC countries as a group. OPEC is treated as an cartel capable of limiting production to support an agreed price. OPEC's revenues are limited by world demand for oil, and by supplies of oil from sources outside OPEC.

As OPEC raises its oil prices, world demand for oil tends to fall because of conservation by consumers, and a shift to alternative energy sources. Counterbalancing these downward pressures on demand are increases in world income. On the supply side, higher OPEC prices stimulate increased oil production in non-OPEC countries. These supply responses are enhanced by technological progress, and are retarded by depletion of reserves.

The analysis uses a simple dynamic model of the international oil market, which includes world demand for oil and non-OPEC supply of oil, with OPEC oil production calculated as a residual. We assume that when OPEC fixes a price for oil it remains constant in real terms for the indefinite future. The model thus estimates the adjustments in world demand and non-OPEC supply to this fixed price. The resulting pattern is unrealistic in that it does not provide for the feed-back of supply or demand changes on



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oil prices themselves. But by working out the logical implications of certain price assumptions the model permits us to focus on whether or not these implications are likely to be acceptable to OPEC or to the consuming countries, or to cause strains within OPEC itself.

We make the following assumptions in our analysis:

-- World demand for oil increases independently of prices at an annual rate of 5%. This is about the expected rate of growth of total world energy demand. That is, demand shifts each year to account for real income changes.

-- The long run price elasticity of supply for non-OPEC oil, excluding the North Sea, is about .6. This estimate was based on pre-embargo projections for the U.S. by the National Petroleum Council. The NPC estimated the rate of US output that could be achieved at various cost-prices up to about \$7 a barrel. We use the elasticity calculated from the NPC to cover high-price levels as well.

-- With regard to North Sea oil we assume that production will rise to about 7 million barrels a day in 1985 for any price we consider.

-- Our demand elasticities are pure guesses; research on this question yields a wide range of results. We assume long-run price elasticities of .25 and .50 for crude oil. These are probably equivalent to elasticities of about .50 and 1.0 for final petroleum products, since crude oil prices on the average now constitute about one-half of the final product price.

-- We allow for time lags in the movement of both supply and demand toward the rates consistent with the assumed long-run elasticities. By 1985 non-OPEC supply has achieved about 75% of its long-run adjustment. Demand adjusts more rapidly than supply, about 75% of the long run adjustment being achieved in 4 years.

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Results

We consider four scenarios: OPEC members set and maintain in 1974 dollars their revenues per barrel at \$5, \$7.50, \$10, and \$15.

At \$5, world oil consumption increases to about 70 or 80 mb/d in 1985, (for the two demand elasticities assumed) and OPEC production increases to about 40 or 50 mb/d or by 10 or 20 mb/d (See Figure 4). The results approximate the conventional wisdom of estimates made before the Arab embargo, with similar price assumptions.

At \$7.50, OPEC production drops slightly during the next 4 years and then increases slowly. (See Figure 5).

At both \$10 and \$15 OPEC production decreases sharply (See Figures 6 and 7). OPEC members would be required to reduce their combined output by more than 60% over the next decade to support the \$15 price. A \$10 price implies a 25% cutback or more by 1980.

Of the four prices, only the \$5 price implies increasing OPEC revenues per day over the next five years. At \$7.50 current revenues decrease through 1980, and level off or increase thereafter. Prices of \$10 and \$15 result in sharp decreases in daily revenues to very low levels if a high price elasticity is assumed (See Figure 8).

Although daily revenues decline under the three high-price assumptions, the highest prices yield the

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the greatest total OPEC take for some time (See Figure 9). With a low demand elasticity, the higher prices maximize revenue for at least a decade. With a high demand elasticity, however, lower prices yield higher total revenues after 1980.

These calculations make no allowance for the return that OPEC countries can obtain by investing their surplus revenues. Such an allowance would increase the desirability of high oil prices, which result in larger revenues in the short-term, but smaller ones in the long-term.

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Conclusions

Results of the four scenarios indicate several generalizations:

-- The higher the price the greater the cumulative OPEC revenues at least through 1985 with a demand elasticity of .25. With a demand elasticity of 0.5 this condition obtains only through 1980.

-- Patterns of revenues per day are similar at both elasticities. At \$15 these revenues drop sharply through 1985. At \$7.50 and \$10 they fall through 1980 and then level out. At \$5 revenues rise slowly.

-- OPEC production at \$10 and \$15 declines dramatically through 1985. At \$7.50 output falls off slowly and begins to recover after 1980. At \$5 OPEC production increases steadily.

-- Non-OPEC production increases its share of total oil production for all prices above \$5 per barrel. At \$5 non-OPEC production follows the upward trend of OPEC output.

These conclusions are for OPEC as a whole. Individual members would, to varying degrees, consider other factors, such as: interest rates on investments; the long-term import needs of their economies; the size of their oil reserves, and political factors.

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Equations

The model we use to evaluate OPEC pricing strategies consists of a few simple difference equations. At the start of an annual quarter t , the non-OPEC share S of the world oil market is fixed, as is the size W of the world market. An OPEC charge per barrel of R implies a total OPEC take for the quarter of

$$(1) \quad T_t = R_t (1-S_t) W_t.$$

Long-run world demand, as function of the OPEC price R and of time t , becomes

$$(2) \quad \hat{W}_{t+1} = \alpha (1+R_t)^{\beta} \gamma^t,$$

where the Greek letters denote parameters, and where we add \$1/bbl. to the OPEC take in order to get a landed price. World demand during the next quarter is then

$$(3) \quad W_{t+1} = W_t + \delta (\hat{W}_{t+1} - W_t).$$

The long-run rate of non-OPEC supply (excluding North Sea production) is

$$(4) \quad \hat{X}_{t+1} = \epsilon (1+R_t)^{\zeta} t^{\eta}.$$

This supply in the next quarter is

$$(5) \quad X_{t+1} = X_t + \theta (\hat{X}_{t+1} - X_t).$$

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North Sea supply in the next quarter is

$$(6) \quad N_{t+1} = \kappa (t)^\lambda.$$

The non-OPEC market share becomes

$$(7) \quad S_{t+1} = (x_{t+1} + N_{t+1}) / W_{t+1},$$

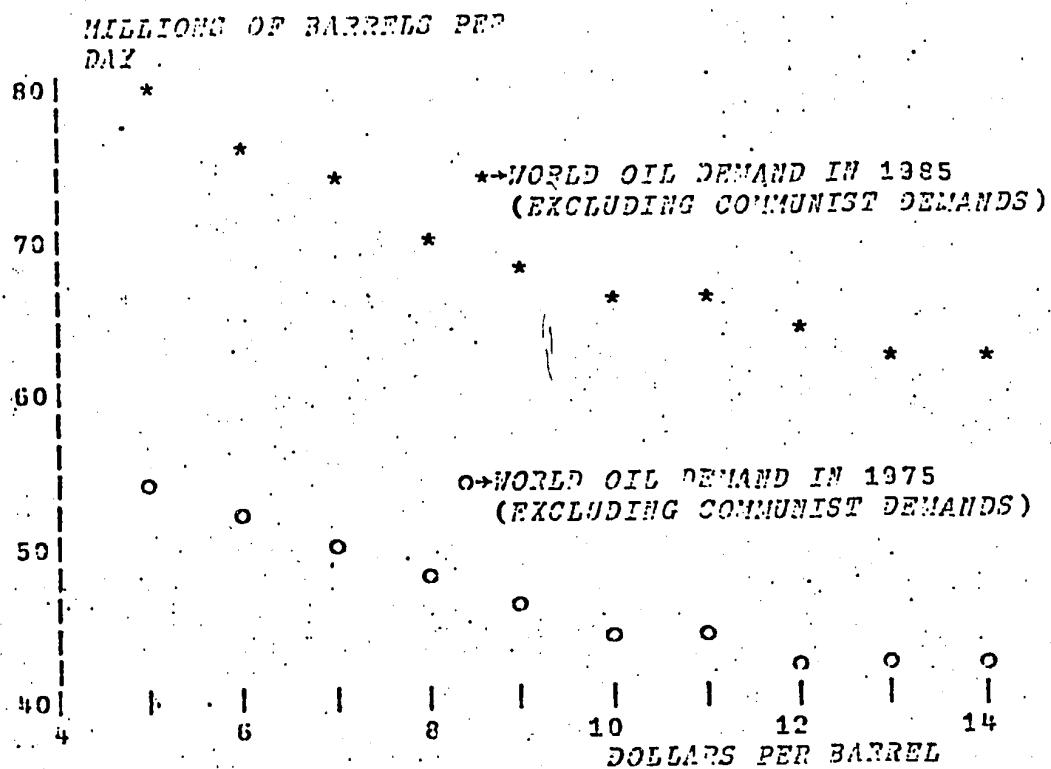
Where S_{t+1} is damped to fall within the interval $(0,1)$.

At the start of quarter $(t+1)$, OPEC sets a new price per barrel of R . Equation (1) then determines the OPEC take. World demands and non-OPEC supplies readjust. By simulating this process through time, we trace production and revenues.

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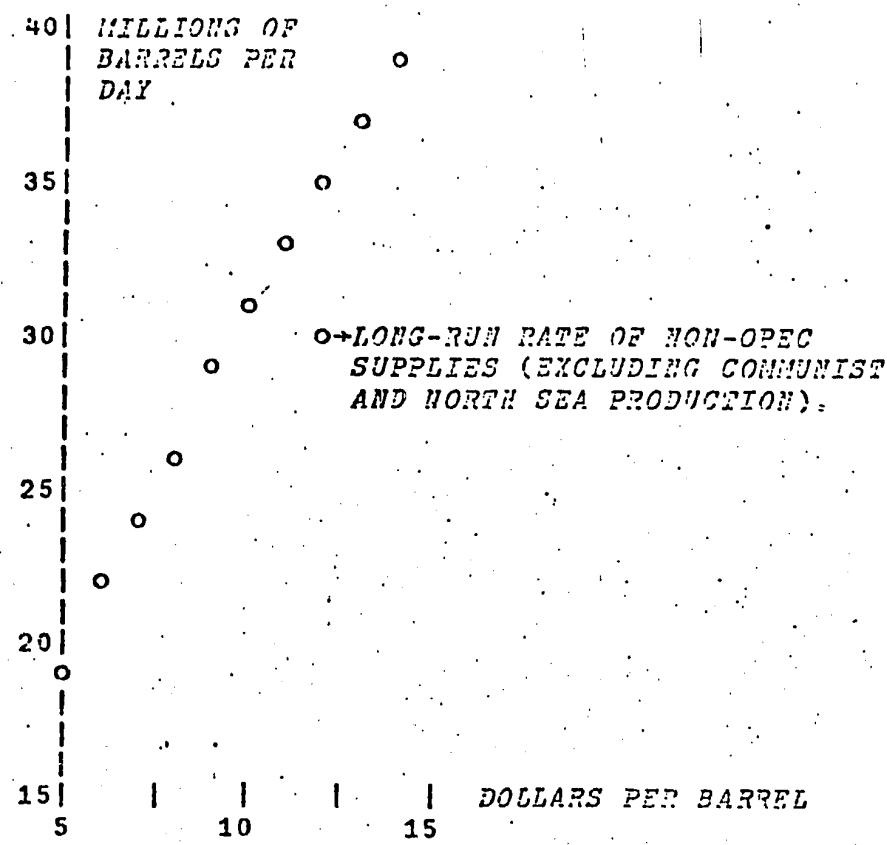
Figure 1
Long-Run Demand Curves



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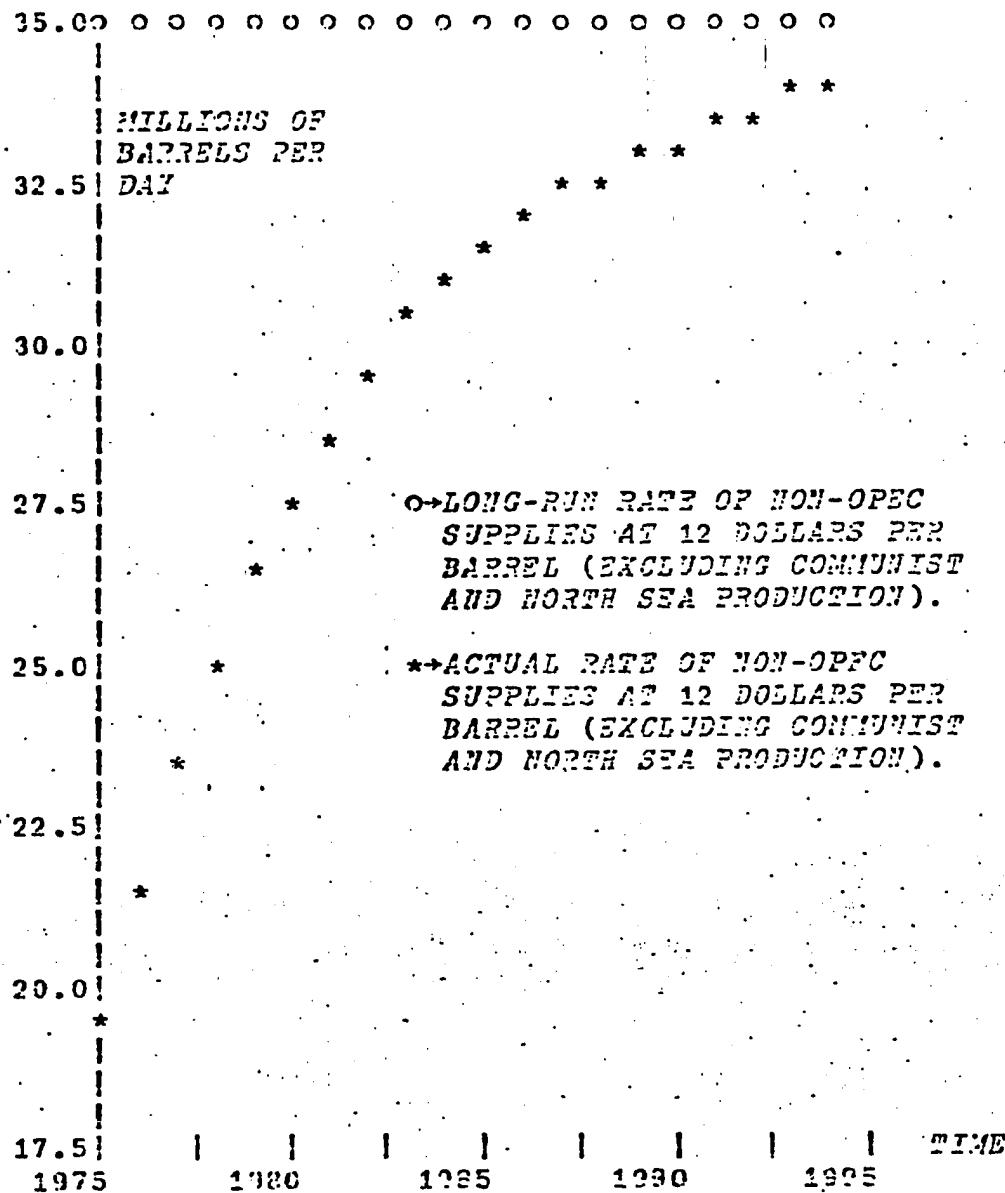
Figure 2

Long-Run Non-OPEC Supplies



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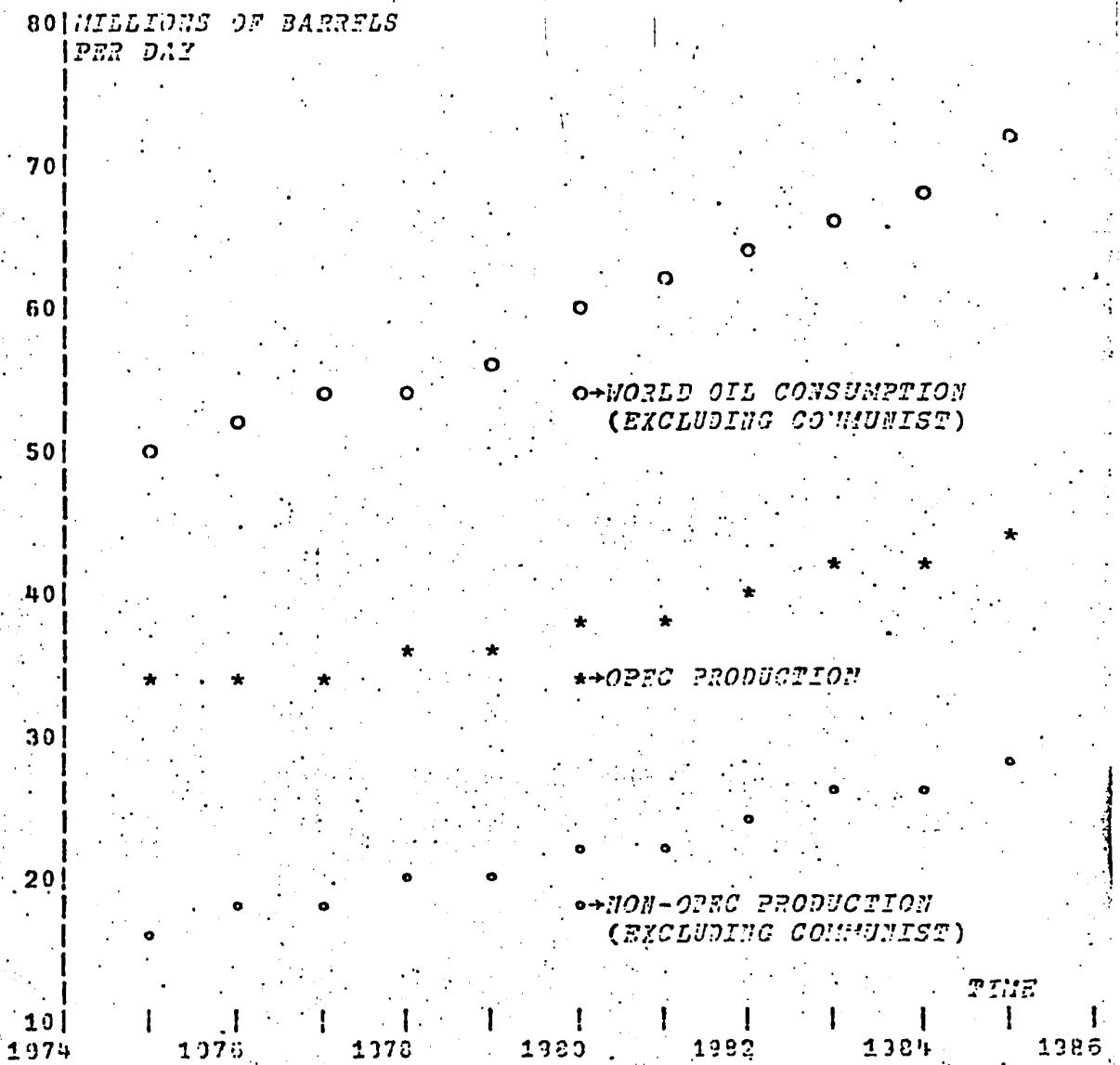
Figure 5

Time Lags in Supply Resources

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Figure 4a

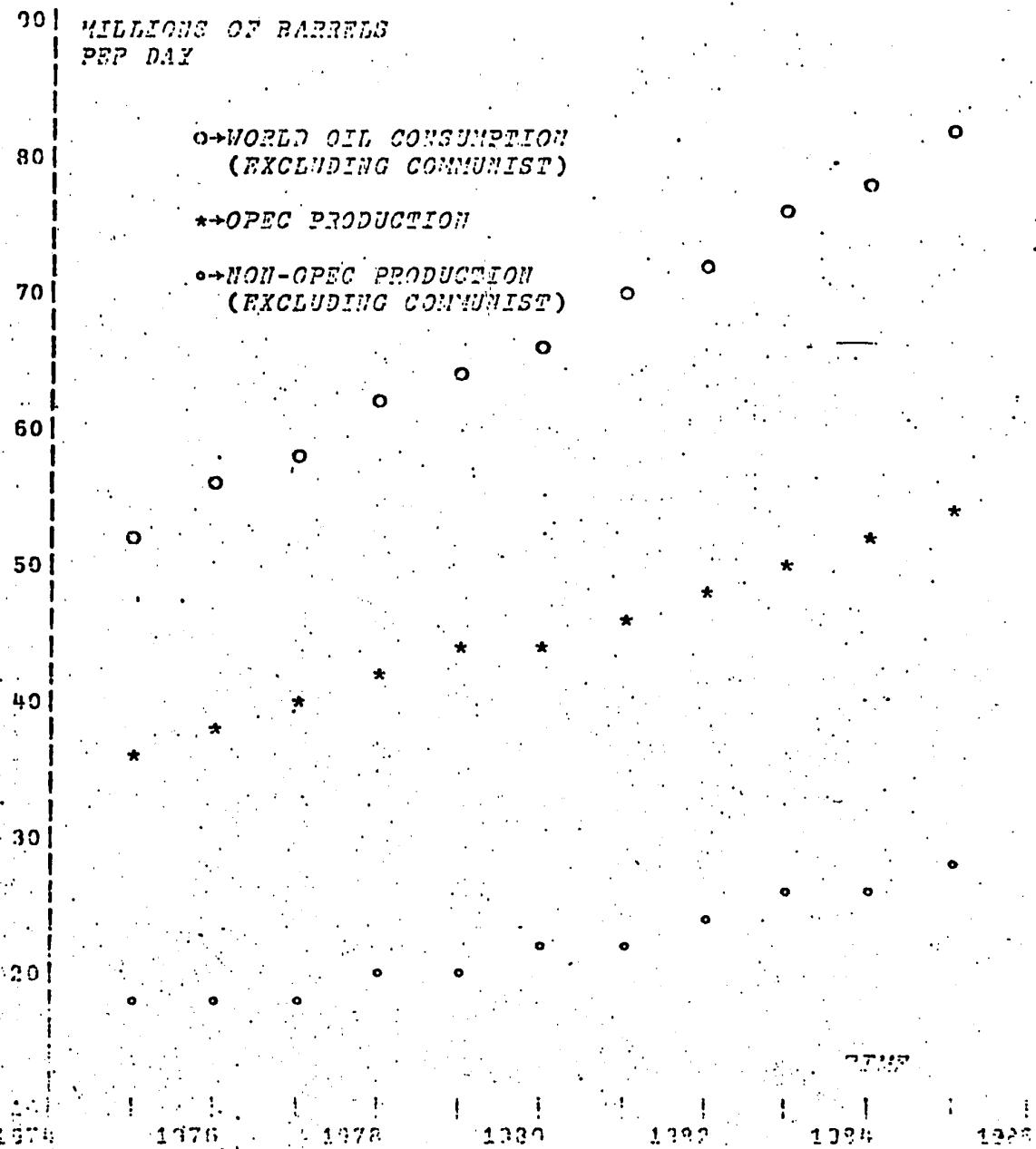
Output and Consumption Trends at \$5/bbl.
 (demand elasticity = .25)



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Output and Consumption Trends at \$5/bbl.
(demand elasticity = .50)

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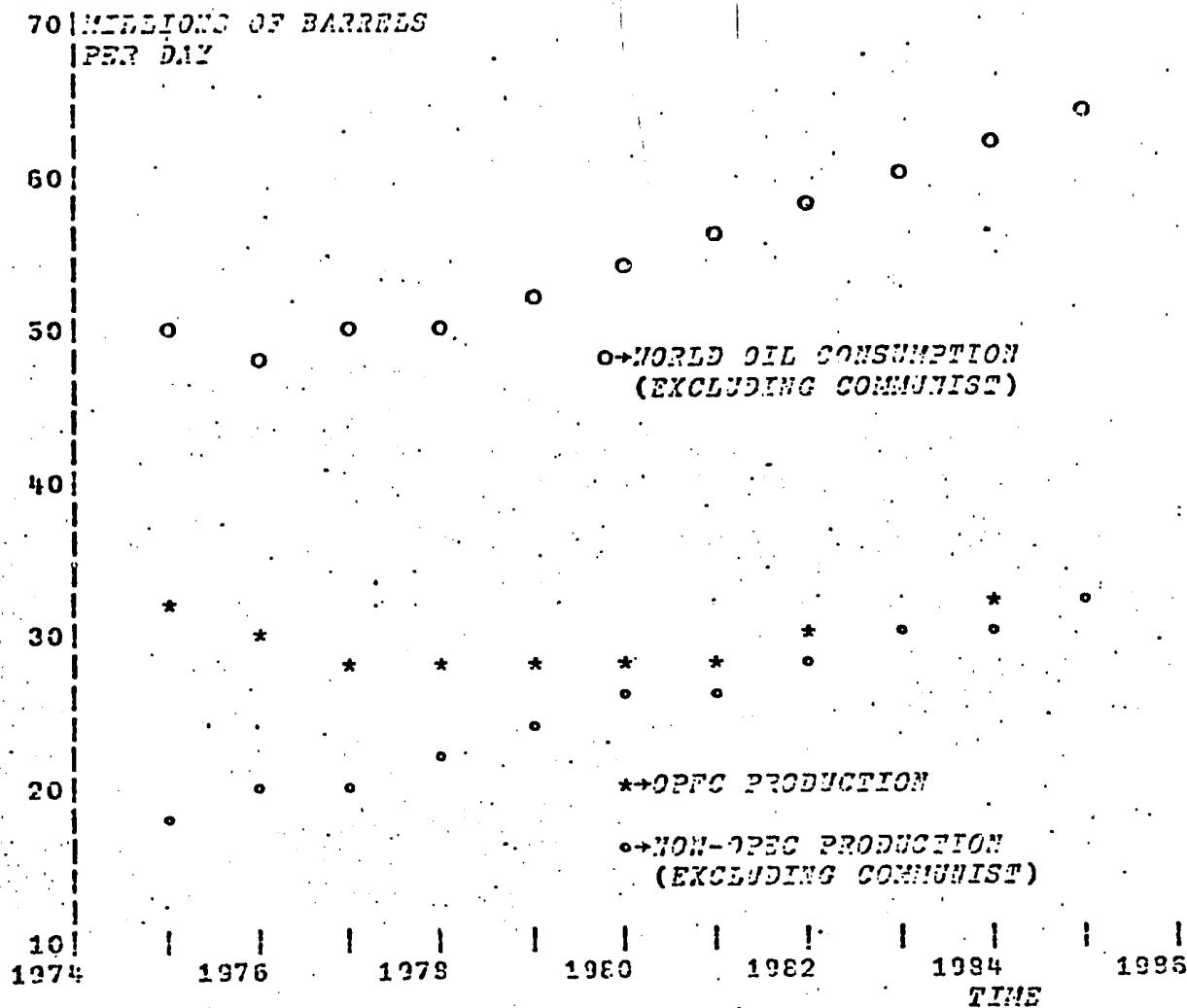


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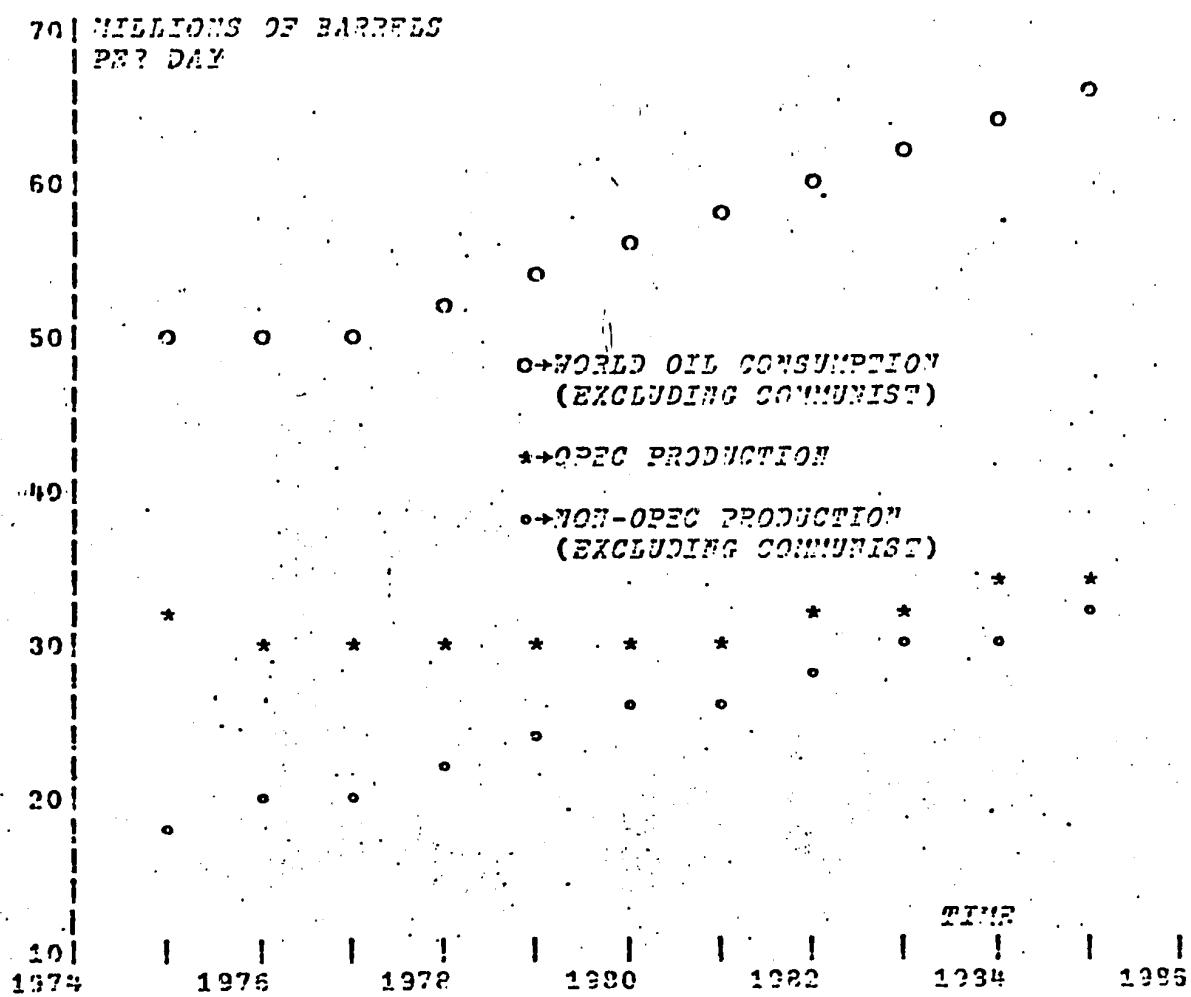
Figure 5a

Output and Consumption Trends at \$7.50/bbl.
 (demand elasticity = .25)



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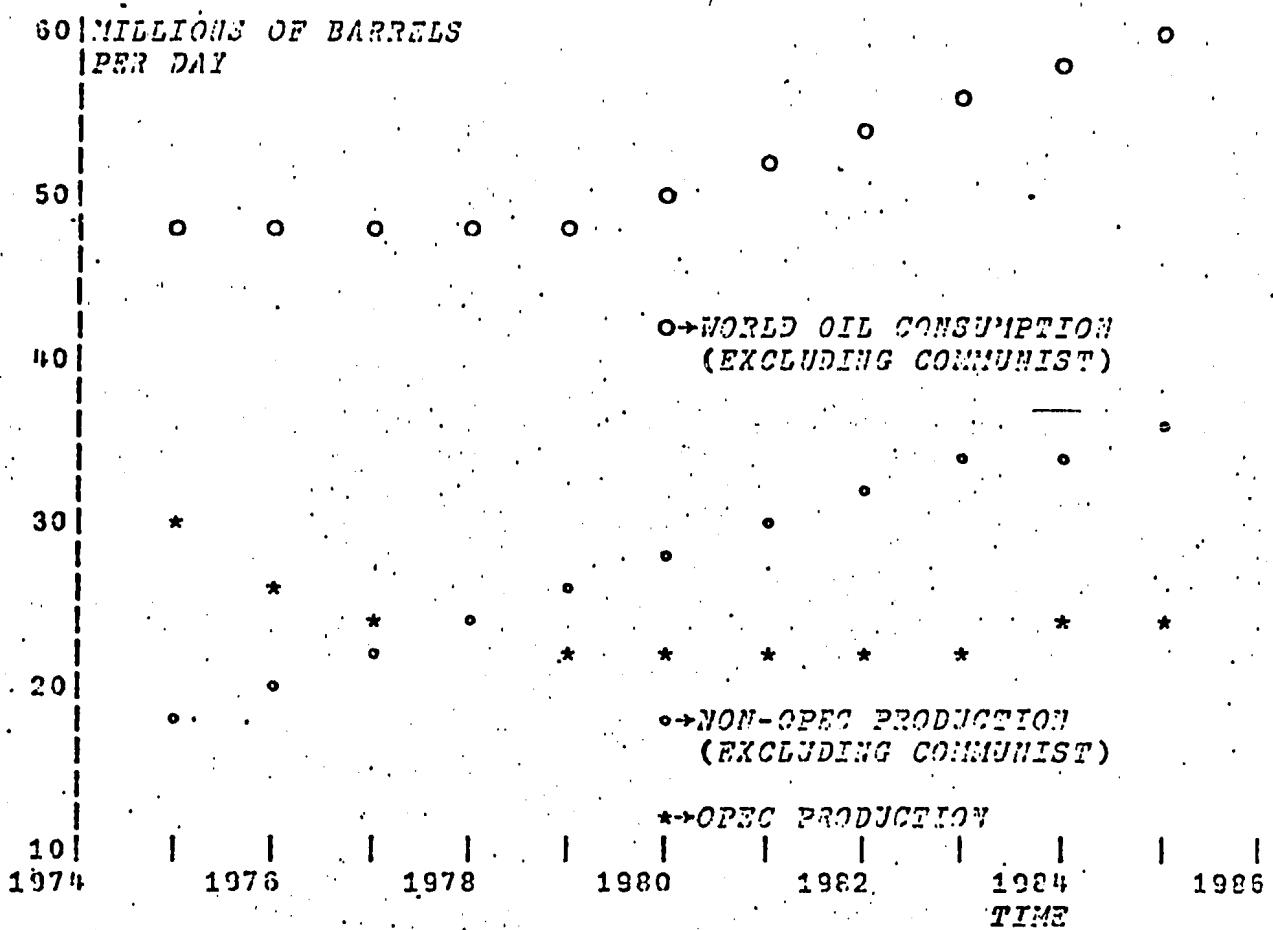
Output and Consumption Trends at \$7.50/bbl.
(demand elasticity = .50)



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Figure 6a

Output and Consumption Trends at \$10/bbl.
(demand elasticity = .25)



Output and Consumption Trends at \$10/bbl.
 (demand elasticity = .50)

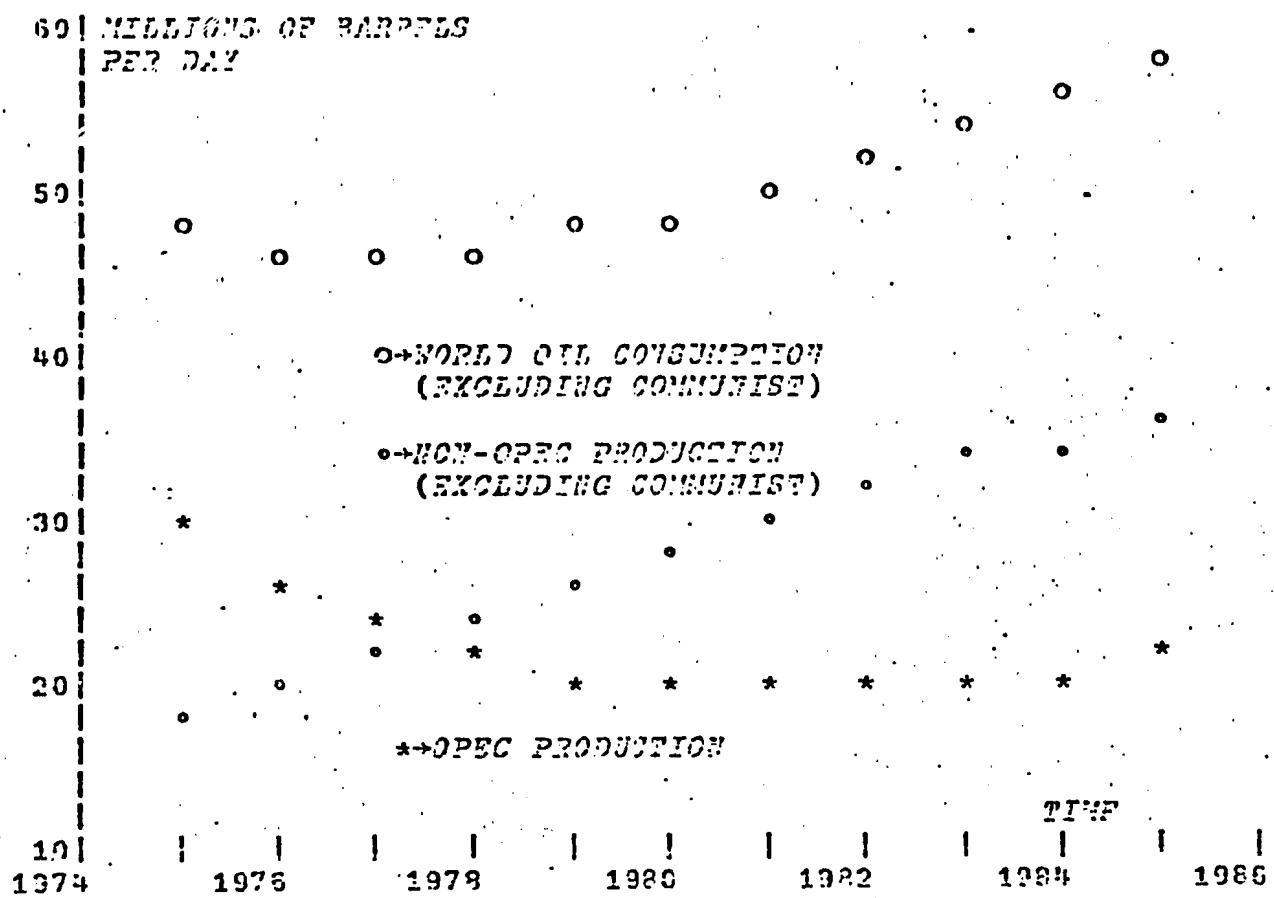
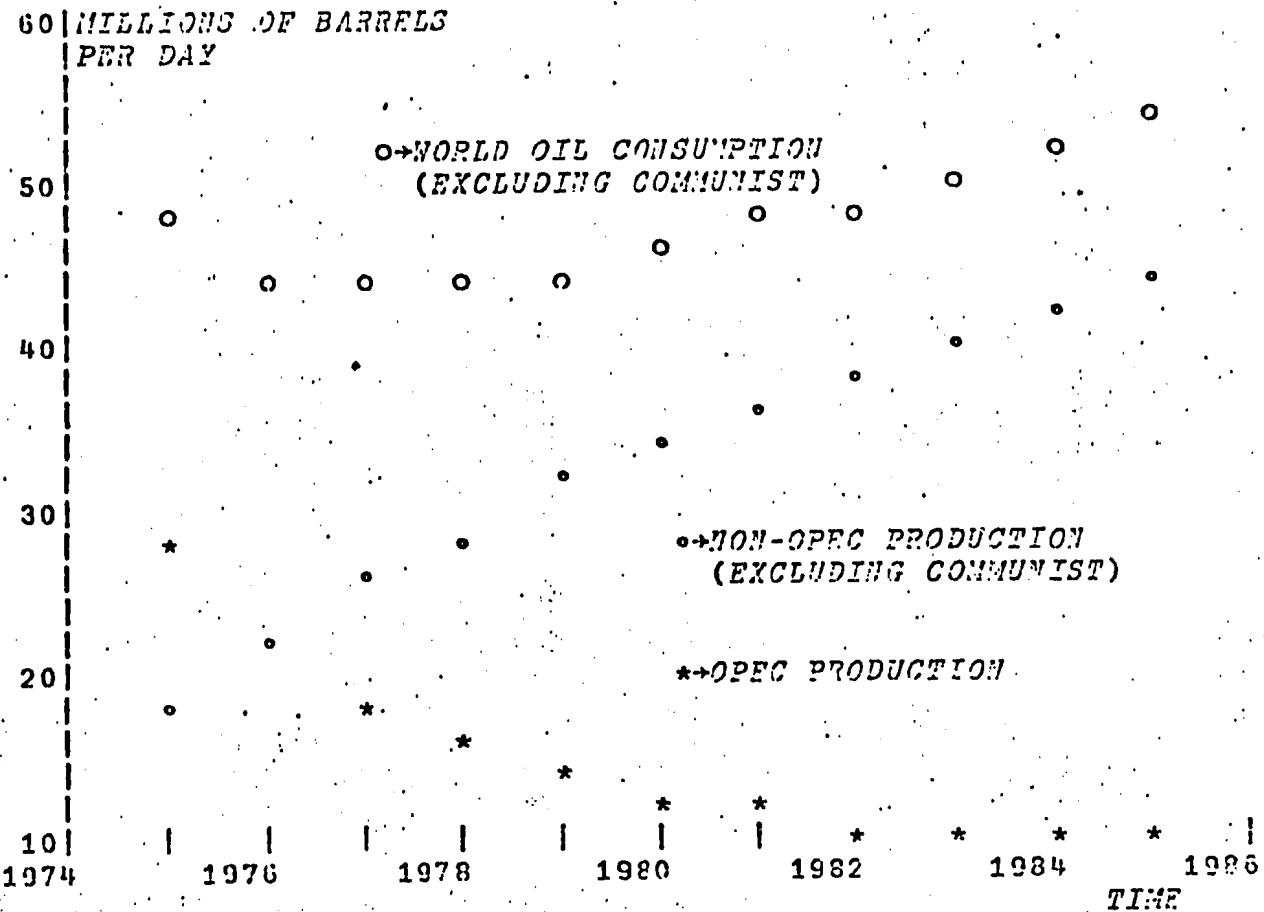


Figure 7a

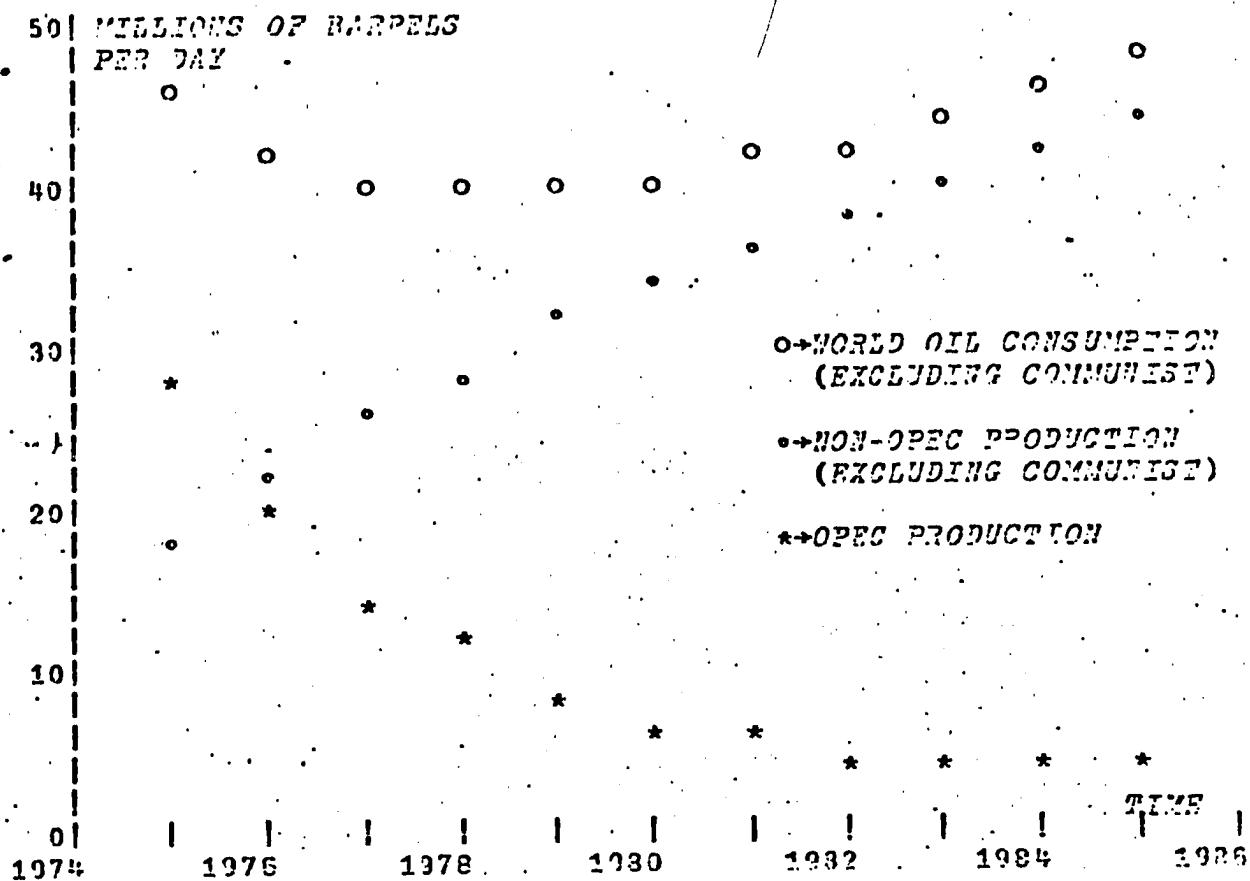
Output and Consumption Trends at \$15/bbl.
(demand elasticity = .25)



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Output and Consumption Trends at \$15/bbl.

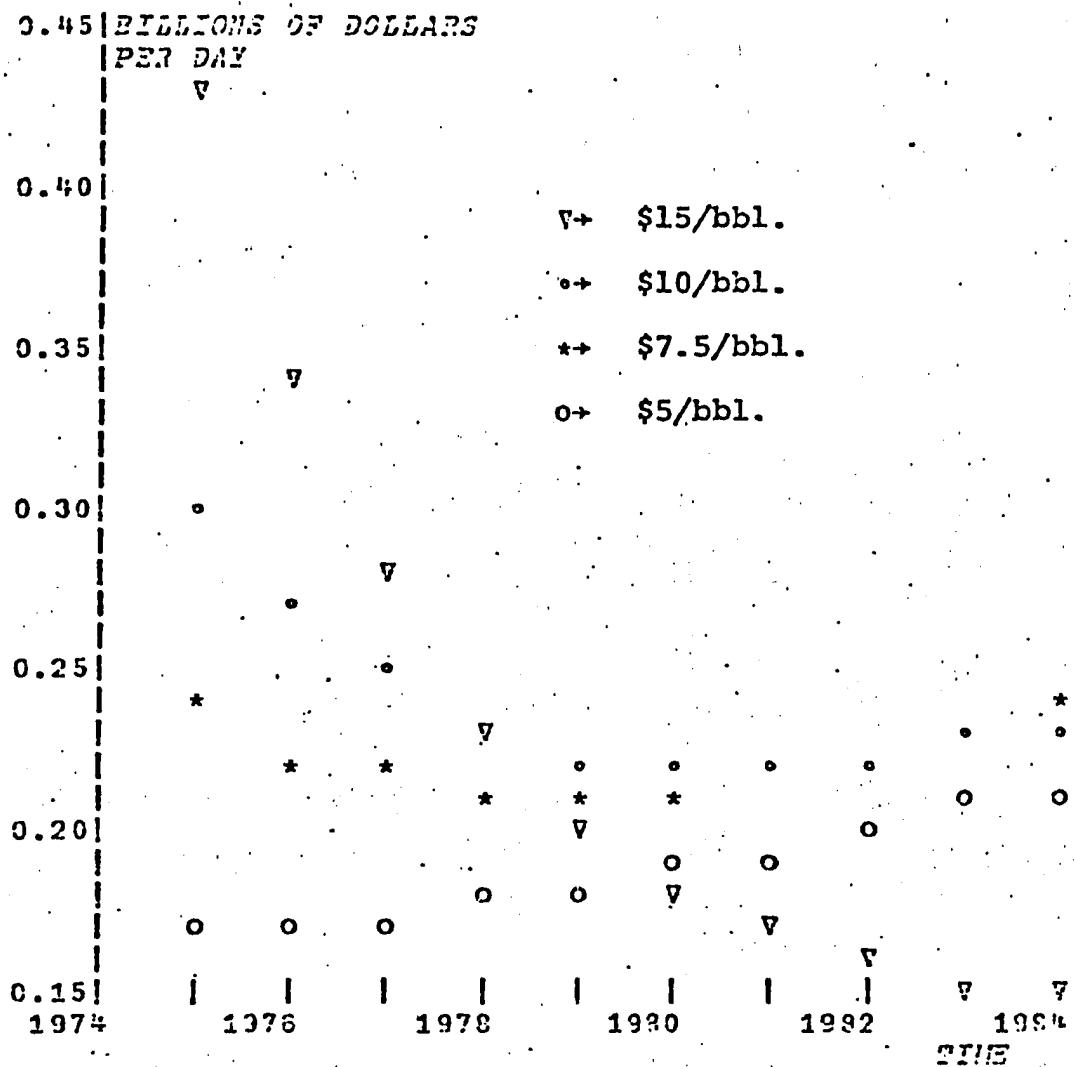
(demand elasticity = .50)



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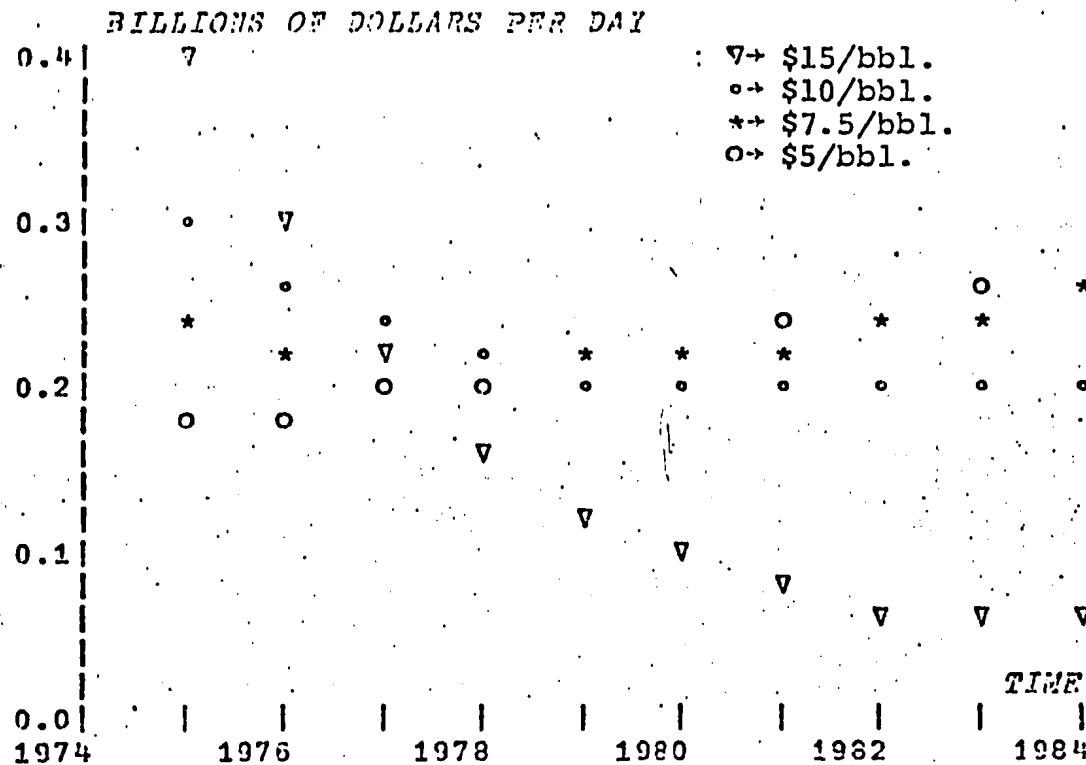
Figure 8a

OPEC Revenues Per Day
Under Alternative Price Strategies*
 (demand elasticity = .25)



* For several years the revenues under different strategies coincide, so that some points are deleted from the four graphs.

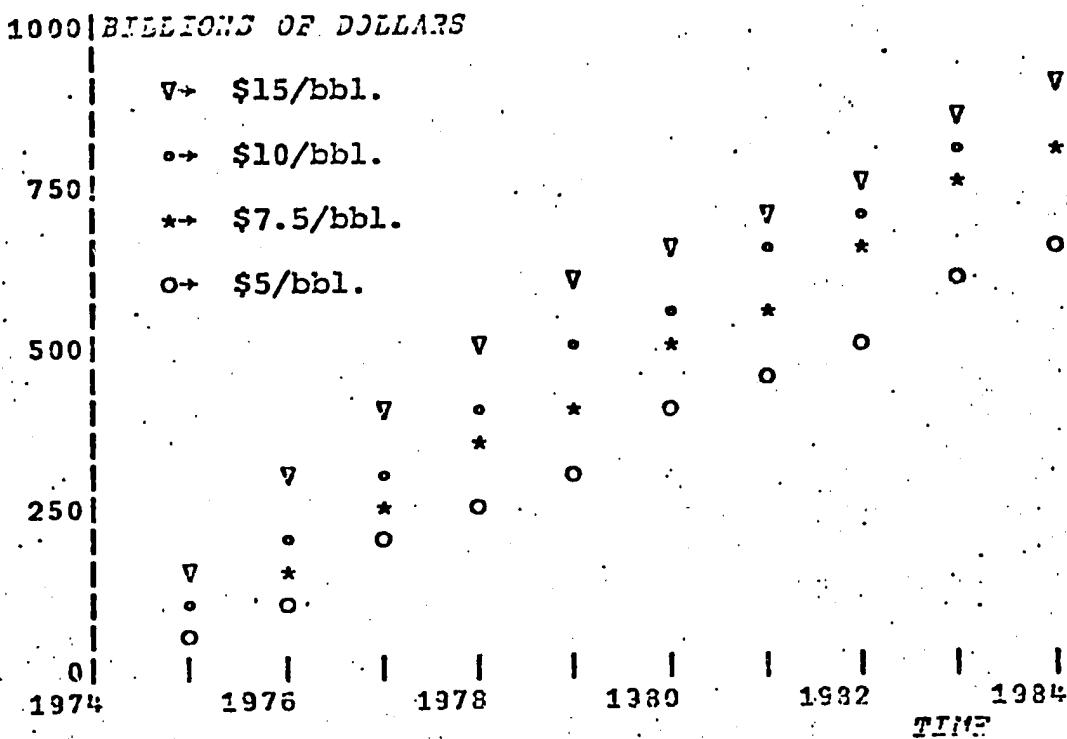
OPEC Revenues Per Day
Under Alternative Price Strategies*
(demand elasticity = .50)



*For several years the revenues under different strategies coincide, so that some points are deleted from the four graphs.

Figure 9a

Cumulative OPEC Revenues
Under Alternative Price Strategies
(demand elasticity = .25)



Cumulative OPEC Revenues
Under Alternative Price Strategies
(demand elasticity = .50)

1000 | BILLIONS OF DOLLARS

750

500

250

0

1974

1976

1978

1980

1982

1984

TIME

▼→ \$15/bbl.
*→ \$7.5/bbl.
•→ \$10/bbl.
○→ \$5/bbl.

Subject:

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